UNIVERSITI PUTRA MALAYSIA

OUTLIER DETECTIONS AND ROBUST ESTIMATION METHODS FOR NONLINEAR REGRESSION MODEL HAVING AUTOCORRELATED AND HETEROSCEDASTIC ERRORS

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OUTLIER DETECTIONS AND ROBUST ESTIMATION METHODS FOR NONLINEAR REGRESSION MODEL HAVING AUTOCORRELATED AND HETEROSCEDASTIC ERRORS

By

HOSSEIN RIAZOSHAMS

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

November 2010

Dedicated to:

My father

Abstract of the thesis presented to the Senate of Universiti Putra Malaysia in fulfilments for the degree of Doctor of Philosophy

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By

Hossein Riazoshams

November 2010

Chairman: Associate Professor Habshah Midi, PhD

Faculty: INSPEM

The ordinary Nonlinear Least Squares (NLLS) and the Maximum Likelihood Estimator (MLE) techniques are often used to estimate the parameters of nonlinear models. Unfortunately, many researchers are not aware of the consequences of using such estimators when outliers are present in the data. The problems get more complex when the assumption of constant error variances or homoscedasticity is violated. To remedy these two problems simultaneously, we proposed a Robust Multistage Estimator (RME).

The heterogeneouity of error variances is considered when the variances of residuals follows a parametric functional form of the predictors. Both Nonlinear model function parameters and variance model parameters must be robustified. We have incorporated the MM, the generalized MM and the robustified Chi-Squares Pseudo Likelihood function in the formulation of the RME. The results of the study reveal that the RME is more efficient than the existing methods.

The thesis also addresses the problems when the assumptions of the independent error terms are not met. We proposed a new Robust Two Stage (RTS) estimator in this regard. The proposed method is developed by incorporating the generalized MM estimator in the classical two stage estimator. The performance of the RTS is more efficient than other existing methods revealed by having the highest robustness measures.

We also proposed two outlier identification measures in nonlinear regression. The Tangent leverage, the NLLS, the M and the MM estimators are incorporated in the formulation of the first outlier identification measures. The formulation of the second measure is based on the differences between the derived robust Jacobian Leverage and Tangent leverage. Both proposed measures are very successful to identify the correct outliers.

Finally, we proposed statistics practitioners to use the formal modeling algorithms to get better inferences. We also suggest them to employ appropriate robust methods for further analysis once a correct model has been chosen. The results of the study based on real data signify that the robust estimator is more efficient indicated by lower values of standard errors when compared to the classical estimator.

Abstrak tesis dikemukakan kepada Senat Uiversiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

PENGESANAN DATA TERPENCIL DAN KAEDAH PENGANGGARAN TEGUH BAGI MODEL TAK LINEAR YANG MEMPUNYAI RALAT BERAUTOKORELASI DAN BERHETEROSKEDASTIK.

Oleh

HOSSEIN RIAZOSHAMS

November 2010

Pengerusi: Profesor Madya Habshah Midi, PhD

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Teknik Kuasa Dua Terkecil Tak Linear (NLLS) dan Penganggar Kebolehjadian Maksimum (MLE) kerap digunakan untuk menganggar parameter model tak linear. Malangnya, kebanyakan penyelidik kurang peka akan akibat penggunaan teknik tersebut jika terdapat titik terpancil pada data. Masalah ini semakin kompleks apabila andaian varians beracat tetap atau berhomoskedastisiti tidak dipatuhi. Untuk menyelesaikan dua permasalahan ini secara serentak, kami mencadangkan Penganggar Multiperingkat Teguh (RME).

Varians ralat yang berbeza dipertimbangkan apabila varians reja mematuhi bentuk fungsi parametrik beberapa pembolehubuh tak bersandaran. Kedua-dua fungsi parameter bagi model tak linear dan model varians bagi parameter mesti diteguhkan. Kami menggabungkan penganggar M, penganggar MM teritlak dan juga fungsi teguh kebolehjadian *Pseudo* Khi Kuasa Dua ke dalam pembentukan PME Dapatan

daripada kajian ini menunjukkan RME lebih efisien berbanding kaedah yang sedia ada.

Kajian ini juga menyebut permasaalahan apabila andaian ralat bebas tidak dipenuhi. Oleh itu kami mencadangkan Penganggar Dua Langkah Teguh (RTS) untuk permasalahan ini. Kaedah cadangan ini dibina dengan menggabungkan penganggar MM teritlak kedalam penganggar dua langkah klasik. Keupayaan RTS didapati lebih efisien berbanding kaedah terdahulu, kerana ianya mempunyai ukuran keteguhan yang tinggi.

Kami juga mencadangkan dua pengukuran pegesanan data terpencil dalam regresi tak linear. Tuasan Tangen digabungkan bersama penganggar NLLS, penganggar M dan penganggar MM ke dalam formulasi pengukuran pengesanan titik terpencik yang pertama. Formulasi kedua pula berasaskan pada perbezaan diantara tuasan teguh Jacobian yang diterbitkan dan tuasan Tangen. Kedua-dua pengukuran cadangan ini sangat berkesan dalam menentukan titik terpencil yang sebenar.

Akhir sekali, kami mencadangkan kepada pengamal statistik untuk menggunakan pemodelan algoritma yang formal untuk mendapatkan inferens yang lebih baik. Kami juga mencadangkan mereka menggunakan kaedah teguh yang sesuai untuk melakukan analisis lanjutan setelah model yang betul dipilih. Hasil keputusan kajian berdasarkan pada data sebenar, menunjukkan bahawa penganggar teguh adalah lebih efisien, ditunjukkan dari nilai ralat piawai yang rendah berbanding nilai penganggar klasik.

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I certify that an Examination Committee met on 3rt Nov 2010 to conduct the final examination of Hossein Riazoshams on his Doctor of Philosophy thesis entitled "OUTLIER DETECTIONS AND ROBUST ESTIMATION METHODS FOR NONLINEAR REGRESSION MODEL HAVING AUTOCORRELATED AND HETEROSCEDASTIC ERRORS" in accordance with Universiti Putra Malaysia (Higher Degree) Act 1980 and Universiti Putra Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the Doctor of Philosophy.

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This thesis was submitted to the Senate of University Putra Malaysia and has been accepted as fulfilment of requirement for the degree of Doctor of Philosophy. The members of Supervisory Committee were as follows.

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DECLARATION

I declare that the thesis is my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently submitted for any other degree at Universiti Putra Malaysia or institution.

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HOSSEIN RIAZOSHAMS

Date:

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